The Current Status of Behaviorism and Neurofeedback

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Abstract

There appears to be no dominant conceptual model for the process and outcomes of neurofeedback among practitioners or manufacturers. Behaviorists are well-positioned to develop a neuroscience-based source code in which neural activity is described in behavioral terms, providing a basis for behavioral conceptualization and education of neurofeedback providers and their clients.
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Neurofeedback, (also called, "EEG biofeedback" or "brainwave biofeedback,") is one of several "neurotherapy" techniques, so-called because of their intended "direct" influence on brain processes. At the time of this writing, it still lags behind medication as the modern western or "scientific" method-of-choice for developing greater brain self-regulation, but the number of clinicians providing this intervention has grown yearly since the early 1980s. Language for describing the intended outcome of neurofeedback appears to be similar across clients, practitioners and researchers (and teachers, family members and journalists) who uniformly identify this outcome as "behavior change" or simply "learning." It is in the description of the underlying process, the "how it works" section of the manufacturer's or clinician's explanation, that great differences are seen. These differences may be due, in part, to lack of standardization in neurotherapy training and therefore great differences in practitioners' conceptual models of learning, and in part to the relative crudeness of the data that provide the feedback.

These data consist of faint electronic signals that are present on the cortical surface, trickle through the skull and skin to a grounded sensor at a specific location. They are then amplified and filtered into a variety of frequency bands or wavelengths, and presented to the client in a stimulating graphic and auditory format. Each behavior of an individual has a unique neural structure, discharged through a set of unique frequency patterns (measured in milliseconds), employing any number of cortical and subcortical regions. Behaviors, whether overt motor functions or covert operations, are not conditioned so much as particular brain states and the general self-regulation of brain states, through reinforcement of the amplitude of selected frequencies relative to other frequencies. Many distinct behaviors are frequency-specific, and neurofeedback, when successful, strengthens the relative amplitude of frequencies that facilitate target behavior.

For the behaviorist, behavioral descriptions trump cognitive ("he knows…") phomenological ("she is much better at…"), humanistic ("he wants to…"), educational ("she has learned that…") and broad clinical ("it effectively changes his…") explanations of behavioral change. O'Donohue and Kitchner (1998) pointed out the "many behaviorisms" that currently exist all have principles and language in common. The behavioral mainstream is a field formally recognized as Applied Behavior Analysis (ABA). ABA involves a conceptual structure that encompasses both broad and specific outcomes – and outcome measures, in terms that are related to the components of the identified problem. Any or all of these components may be addressed by interventions particularly suited to changing the parameters of problematic behavior so that they resemble the parameters of the goal or specified outcome. It is a prolonged lament by many behavioral practitioners (including this author -- see Fultz, 2001) that the nature of a particular learning process or behavior change event such as neurofeedback training, is unnecessarily obscured by a sloppy explanation. In a utopian therapeutic environment one's language would merely reflect the worldview -- or perhaps the cosmology -- of the person, but one suspects it

often indicates a lack of understanding of ABA concepts. The primary intent of this article is not to dismiss the above-mentioned epistemologies, but to argue for the superiority of behavioral explanations of neurofeedback processes and outcomes, then to temper this hubris with caveats about one's audience and appropriate levels of analysis and explanation.

Manufacturers and marketers of neurofeedback equipment tend to emphasize outcomes in broad terms having to do with better grades, better behavior, better relationships, more positive emotions, and – conversely – fewer problems. Neurofeedback is often globally categorized as a powerful "noninvasive intervention" resulting in relatively permanent brain changes, a description meant to distinguish neurofeedback from medication-based therapies. Marketing of neurofeedback services by clinicians tends to involve broad outcome language, in addition to descriptions that appear to reflect practitioners' own epistemological orientation. It is presented as a teaching tool, a brain exercise machine, a mindfulness-training instrument, a catalyst for getting the brain "unstuck" and a "strange attractor generator," exposure to which will free the human inside and foster the natural spontaneity, creativity and joy that is the birthright of every human being. Education and exercise metaphors are common, the "Rousseauian-Buddhist-Chaos Theory" perspective less so.

Neurofeedback was conceptualized, developed and presented as strictly an operant conditioning procedure in the 1960s and 1970s by pioneers such as Barry Sterman and Joel Lubar, and a number of clinicians continue to describe the procedure in operant language, although – from an ABA standpoint – conceptual purity is often lacking. Ubiquitous use of the term "reward" is one example of this conceptual impurity; it allows for a social, subjective and merit-based contingency as the operative mechanism, along with notions about what the client wants or thinks or "tries" to accomplish. A clear conceptual understanding of the nature -- and therefore the use of -- "reinforcement" would facilitate understanding of the operative mechanism (the "active ingredient") in neurofeedback at macro- and micro-levels of behavior. Reinforced behaviors are strengthened as a function of the administration contingency, whether they are as complex and multidimensional as improved attitudes or skills, or as rudimentary as a single neuron firing at a lower stimulation threshold. In addition to the social and emotional baggage of "reward," it is increasingly difficult to convey its intended meaning at increasingly microanalytic levels. For example, while neuroscientific research has continued to explore the nature of reinforcement as the altering of neurotransmitter and neural field configurations (see, for examples, Boucher, Palmeri, Logan & Schall(2007) and Arbib (2002) – several articles), it is inconceivable that a particular excitatory or inhibitory burst discharge at a specific location in the midbrain would be predictably produced by local, micro-level "rewards."

The requirement of bilingualism is a point of solidarity for behavioral practitioners. One must speak to the public so that they understand, and speak to one's professional peers in the language of the profession. The esoteric nature of precision and expertise about the infinite patterning of organisms and environments requires a linguistic clarity that reeks of "arcane minutiae" to the general public. Neurofeedback processes and outcomes are (ideally) explained differently to children and psychology students. One is likely to question numerous neurotherapists and vendors and find that they are unable to transition from the language of "brain exercise" and "better control" to even slightly more specific descriptions involving "shaping," "S_D" or "habituation." Theoretically, behaviorism provides not just a descriptive but an explanatory structure that is widely applicable for many levels of analysis and practice. Staddon (1998) points out that both neuroscientists and therapists now generally see even cognitivism and behaviorism as entirely in agreement.

Among modern behavioral psychologists the notion appears to be widespread that all manifestations of human activity, including emotions and personality characteristics, are not just "epiphenomena" but are manifestations of neural structure, and at the neural level "the psychologies of structure, function, and development" (Catania, 1973) are indistinguishable. Cacioppo and Decety's (2009) appeal to move

beyond a science of behavior (or a competing science of the mind) suggests that an integrating "science of the brain" is a realistic endeavor, given continued neuroscience achievements. Theoretically it is a small matter to propose that a complete description of the neural components and processes underlying behavior would be so precise as to brilliantly illuminate all aspects of an intervention such as neurofeedback. For the average client the utility of such a detailed description would be analogous to the process of reading a road map through a microscope, although it may be reassuring that one's driver is able to do so.

Behavioral training is generally not required for providers of neurofeedback services, but the components and process of neurofeedback intervention are well-suited for behavioral conceptualization and articulation. Insights from neuroscience research about the nature of physiological processes underlying behavior provide behaviorists with a rich opportunity to develop the source code repertoire to which all neurotherapy participants may subscribe. Behaviorism as a personal and professional therapy model (and not just a mélange of terms and techniques used in a slipshod manner) may yet occupy a central role in neurofeedback and other neurotherapies. For those in the behavioral fold who retain antipathy toward "mentalism" and "black box empiricism," who so easily dismiss "mindfulness" or personality epiphenomena as unworthy of the craft, an opportunity is knocking. What was once dismissed and scorned by staunch behaviorists may be translated into the behavioral model by those who will embrace Cacioppo and Decety's (2009) science of the brain.

Computer science metaphors for brain activity are overused, but the field does provide a model of three language levels that may be of use here. Individuals are served through the user interface (software and hardware for specific applications/jobs, professional programmers use programming language for developing underlying functional processes – to solve specific problems or provide specific services, and these languages must be developed by those who have an understanding of central processors and the "machine language" through which all functions are propagated and modulated. The "machine language" of behavioral neuroscience is a firm basis on which to develop behavioral programs for neurofeedback-type applications.

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